Remarks:

A. Section 102(b) Rejections

Claim 1 Rejection

1. (currently amended) A method of combusting a liquid primary fuel comprising the steps of:

establishing a zone of combustion, spaced from a fuel nozzle, and defined by a flame of ignited hydrogen,

dispersing a liquid primary fuel through said nozzle into the zone of combustion in a partially vaporized and partially atomized state, and

burning the vaporized liquid primary fuel and the atomized liquid primary fuel entering said zone of combustion.

Claim 1: Houseman's disclosure and claims *all* refer to a "hydrogen generator," whose purpose is to produce a hydrogen-rich stream for use in a downstream process, such as an internal combustion engine. Hydrogen is a specified and intended *product* of the reference device. The reference only suggests the presence of hydrogen as a component when a small portion of the hydrogen generated is recycled back to the fuel/air mixture for the purpose of lowering the potential of soot formation (P. 6, Paragraph 4). The present invention, with regard to Claim 1, cannot have been anticipated by the reference at the time of its invention for at least the following reasons:

- Houseman does not refer to "establishing a zone of combustion, spaced from a fuel nozzle, *and defined by a flame of ignited hydrogen" (*emphasis added). In referring to Figure 5 of the Houseman reference, the flames generated by this device combust in a chamber **56** where, in an oxygen-starved environment, a *hydrogen-rich gas stream is generated.* In Houseman, fuel and air are mixed and combusted in *one flame front* which is contained within the chamber **56.** In the present invention, *two separate and distinct combustion events* are created (See Fig. 1, items **10** and **11**). This differs from the reference in at least three significant ways: 1) Houseman does not provide for a separate hydrogen stream that travels through a dedicated conduit means and burns in its own combustion zone separate from the fuel, 2) Houseman does not ignite the hydrogen stream as *separate* step in the combustion method from the ignition of the fuel stream, and 3) the Houseman device produces a hydrogen rich stream by partial oxidation of the fuel, whereas the present invention produces hot flue gas by total oxidation of the fuel stream.

- Since vaporized hydrocarbon fuels and hydrogen have vastly different physical and combustion properties, co-firing these fuels in a single chamber to near complete combustion is generally not feasible. The present inventor's refer to this problem in Paragraph 8 of the specification:

> "....Secondly, hydrogen's flame velocity is more than 8 times as fast as a typical heavy fuel oil flame velocity. This characteristic

makes co-firing by conventional burners largely ineffective because the hydrogen burn rate substantially outpaces the fuel oil burn rate and the flame propagation may not be stable without a large excess of hydrogen."

Since the reference neither discloses any observed problems with hydrogen co-firing (because this was not the intended or envisioned use of their device), nor discloses any means or intent to separate the hydrogen combustion from the fuel combustion (because this was not the intended of envisioned use of their device), there can be no inherent anticipation in the reference to Claim 1.

- The specification or claims of the Houseman reference do not contain any text regarding a "hydrogen flame." The present invention contains significant disclosure as to means for establishing the "hydrogen flame" set forth in Claim 1. The lack of any means to produce or text describing a separate and "hydrogen flame" from a "fuel flame" in the reference must preclude any finding of anticipation.

Claim 2 Rejection

2. (currently amended) The method of claim 1 wherein the zone of combustion is established by the steps of:

providing a pressurized source of hydrogen through a conduit having a discharge opening adjacent to said zone of combustion,

igniting the hydrogen discharged through said discharge opening to produce a hydrogen flame; and

rotating the hydrogen flame about a longitudinal axis of the zone of combustion.

Claim 2: This claim refers to the steps for creating the hydrogen flame combustion environment (area **10** of Fig. 1). Houseman cannot anticipate these steps for at least the following reasons:

- In Houseman, a hydrogen-rich gas stream is the *intended product* by combustion of a fuel in an oxygen-deprived environment. In the present invention, hydrogen from a *pressurized external source*, is delivered and ignited in the device for the purpose of igniting a separate fuel-oxygen source. Thus, in comparing the Houseman reference to the present invention, we have two mechanically different devices, each with significantly different combustion objectives, used to create two fundamentally different combustion environments to achieve these different objectives. The only real similarity in these two devices and combustion methods is that a combustion event of some kind occurs in each.

- From Houseman, p. 5, lines 23-32,

"...the pre-mixed gases are directed into two helical tubes respectively **70, 72** and the two passages between the tubes are thereafter directed into the combustion chamber as a strongly outwardly rotating annulus of gas represented by four streams that merge as they come out, two of which are shown as **74, 76**. The length of the flame that exists can be tailored by changing the angle of the helical path in the burner **(16)**."

This passage sets forth the inventor's intent behind the coil means **70, 72** for rotating the combustion air and a portion of the fuel (that which is vaporized) prior to entry and ignition in the combustion chamber. The present invention differs substantially from this disclosure in at least the following ways:

1) the pair of static helical tubes are replaced by a plurality of non-helical tubes contained within a rotating shaft,
2) the vaporized fuel/air mixture is replaced with hydrogen and oxygen gases generated from an external source (different gases, different purposes),
3) the rotational velocity of the gases inside the non-helical tubes can be increased in the present invention by a rotating means (shaft) to improve combustion properties (a feature not available nor disclosed in the Houseman reference), and
4) Houseman's purpose of the helical tubes is to create a swirl of the combustion air around the atomized fuel. In the present invention, rotating hydrogen flames about a central axis is designed to provide the highest amount of hydrogen flame front contact with the atomized fuel, and at the same time minimizing the amount of hydrogen needed by the system. (Note: this is a complex concept that took the inventors years of research, design and testing to accomplish. The Houseman reference would have provided no useful information to teach the present inventors how to do this.)

Claim 5 Rejection

5. (currently amended) The method of claim 2 wherein said discharge opening is radially spaced from said longitudinal axis and angled toward the central axis of rotation.

Claim 5: In reference to Fig 6 and p. 5, lines 23-31, of Houseman, the opening of the helical tubes appears *not* to be "angled toward the central axis of rotation" as set forth in claim 5 of the present invention. Rather, in Houseman, the discharge opening of the helical tubes is parallel to the axis of the combustion chamber.

Claim 9 Rejection

9. (currently amended) The method of claim 1 where said primary fuel is selected from the group comprising processed and unprocessed vegetable oils, by-product oils from agricultural products processing, liquid and liquefied petroleum fuels and liquid and liquefied animal fats.

Claim 9: This claim is not anticipated due to the arguments set forth for claim 1, on which it depends.

11. (currently amended) The method of claim 1 further including a step of injecting a controlled rate of an additive selected from steam or water into the zone of combustion to control the formation of oxides of nitrogen.

12. (currently amended) The method of claim 11 wherein the injection of said additive is accomplished by pre-mixing the water at a controlled rate with the liquid primary fuel.

Claims 11 and 12: These claim cannot be anticipated by the Houseman reference 1) due to the arguments set forth for claim 1, on which it depends, and 2) the reference does not disclose the use of water or steam as an additive to control NOx formation, including the pre-mixture of the additive with the primary fuel prior to combustion.

Claim 21 Rejection

21. (new) The method of claim 1 wherein the zone of combustion is defined by generally conical surface symmetric about a longitudinal axis.

Claim 21: This claim cannot be anticipated by the Houseman reference 1) due to the arguments set forth for claim 1, on which it depends, and 2) conical surface of the hydrogen flame front is specifically accomplished by rotating the plurality of *hydrogen flames* about a central axis where the hydrogen/oxygen outlet ports are angled toward that central axis. This geometrical arrangement is necessary for the conical surface to be formed and the Houseman reference does not disclose a similar geometrical arrangement (see also arguments for Claim 2 above).

Other General Arguments Against Anticipation

According to MPEP, Section 701, a rejection based on 35 U.S.C. 102(b) can be overcome by "(p)ersuasively arguing that the claims are patentably distinguishable from the prior art(.)" To anticipate a claim, the reference must teach every element of the claim. (See Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987) ("A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.") In Richardson v. Suzuki Motor Co., the Federal Circuit further defined "anticipation" to require "(t)he identical invention must be shown in as complete detail as

is contained in the ... claim." Richardson v. Suzuki Motor Co. 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

In comparing the Houseman reference to the present invention, the only true similarity is that both methods and devices accomplish a combustion event. However, the two methods and devices quickly diverge as the intent of their function and means for which that function is achieved are detailed in the specification and claims. The claim language, the steps used to accomplish the combustion, the purpose of the various steps, and geographical representation of the combustion zones are markedly different in these two disclosures. The clear differences set for in the arguments above must preclude any finding that the "identical invention" is disclosed in any two claims of the reference and the present invention.

B. Section 103(a) Rejections

Claim 3 Rejection

3. (currently amended) The method of claim 2, further comprising the step of setting a speed of the rotating hydrogen flame to optimize a combustion efficiency of the primary fuel.

Claim 3: The stable rotation of a plurality of hydrogen flames cannot be "taught" to one skilled in the art by the disclosure in the Houseman reference. Hydrogen combustion is very different that hydrocarbon combustion. The specific flame temperature, forward flame velocity, and combustion stochiometry are extremely different between these to fuel types and years of experimentation were required by the inventors to control the hydrogen flames while they are being rotated. The difficulty of generating stable hydrogen flames while adjusting the speed is described in detail in paragraphs 4, 26 and 27 of the specification of the present invention. Only through careful experimentation could these problems have been identified and controlled to produce the desired result. The present inventors also experimented with hydrocarbon fuels, such as methane, propane and acetylene (in lieu of hydrogen) and could not obtain effective results (affidavits can be provided). The Houseman reference is completely silent with regards to problems associated (and overcome) with high-speed rotation of hydrogen and oxygen gases. Houseman also fails to disclose any related effect that speed of the fuel/air gases exiting the helical tubes might have on product yield or flame stability (Houseman only suggest flame changes by adjusting the angle of the helical path (Houseman, p. 5, lines 30-32). Further, the language of claim 3 states that adjusting the speed to optimize combustion efficiency of the primary fuel is an additional limitation to *claim 2*. Although speed control may be a common mechanical concept, it is the adaptation of that concept to the other limitations set forth in the dependent claim that must be considered. Houseman cannot be cited as an obvious modification if 1) it does not set forth the same elements as in Claim 2 (i.e., claim 2 is not obvious), and 2) the reference is completely silent with regard to the effect on combustion efficiency of varying flame rotational speed.

Claim 4, 22 and 23 Rejection

4. (currently amended) The method of claim 2 where the source of hydrogen flowing through the conduit comprises a predetermined mixture of hydrogen and oxygen

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22. (new) The method of claim 4 wherein that predetermined mixture of hydrogen is a molar ratio of hydrogen to oxygen having a value of 2:1.

23. (new) The method of claim 22 wherein the source of hydrogen and oxygen flowing through the conduit is obtained from the electrolysis of water.

Claims 4, 22 and 23: The use of a predetermined mixture of hydrogen and oxygen was determined to be effective by careful experimentation. The use of hydrogen alone was found not to be effective because the flame front stability could not be achieved. No only does the reference fail to disclose the use of a hydrogen from an external source as a fuel to support combustion, it also fails to disclose any relationship between oxygen present in that hydrogen fuel as it related to control of the stability of the hydrogen flame. Claims 22 and 23 must be read as additional limitations to claim 4. The Examiner's objection to claim 23 is considered reasonable and claim 23 is withdrawn in consideration of the Examiner's arguments.

Claim 6 Rejection

6. (currently amended) The method of claim 2 wherein a speed of the rotating hydrogen flame in a circumferential direction is not less than the forward flame velocity of the ignited hydrogen.

Claim 6: The reference cannot be anticipator with respect to this claim 1) due to the reasons set forth for Claim 3 above, 2) the discovery of the effect of rotational speed relative to the hydrogen's forward flame velocity was determined by significant experimentation and testing, 3) no reference is presented suggesting that anyone skilled in the art of combustion would understand this relationship absent careful experimentation, and 4) the reference is completely silent with regard to the limitation of rotational speed on hydrogen flame stability.

Claim 10, 22 and 23 Rejection

10. (currently amended) The method of claim 2 where the step of providing pressurized hydrogen from the hydrogen source further includes the steps of:

generating a constant rate of hydrogen and oxygen gases from the electrolysis of water, and

transferring the hydrogen and oxygen gases into a fixed-volume staging chamber such that the hydrogen and oxygen gases are continuously exposed to an inlet opening of conduit.

Claim 10: Although the generation of hydrogen and oxygen gases from the electrolysis of water is a well-known technology, the step of controlling those gases in a pressurized staging chamber such that flow of these gases can enter into the conduits and travel to the opening for combustion is an *additional* limitation that must be considered with respect to this claim. Several designs were considered, design and tested to provide an effective means for delivering the gases to the combustion zone. The use of a fixed-volume

staging chamber is presented as the inventor's preferred means. This means has certain advantages to accomplish the combustion objectives. The Houseman reference does not contain any disclosure as to use of a fixed-volume chamber around a rotating device to provide a stable flow of hydrogen and oxygen to a plurality of hydrogen flame tips.

Other General Arguments Against Obviousness

In Stratoflex, the Court further defined the Deere test for obviousness to include an examination of whether the differences *as a whole* between the prior art and the present invention would have been obvious. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 218 USPTQ 871 (Fed. Cir. 1983); See also (Scheneck v. Norton Corp. 713 F.2d 728, 218 USPTOQ 689 (Fed. Cir. 1983). By similar analysis to the Startoflex case, because the "insight" used in the present invention to produce separate but partially interacting hydrogen and primary fuel flame fronts is not set forth in the "understandings and expectations" of the Houseman reference, "the structure (method) effectuating it would not have been obvious to those skilled in the art." Stratoflex, 713 F.2d at 785, 218 USPTOQ at 700 (citations omitted).

A similar argument against obviousness can be made considering the *In re Hirao* case where nonobviousness is admitted in a claim of a combination where several steps are presented. The Court in Hirao stated that "due to the admitted nonobviousness of the first two steps of the claimed combination of steps, the subject matter as a whole would not have been obvious to one of ordinary skill in the art at the time the invention was made. In re Hirao, 535 F.2d 67, 190 USPTOQ 15 (CCPA 1976). In the present invention, the obviousness objections were made to as to claims dependent on claim 2, which is itself dependent on claim 1. If claims 1 and 2 are admittedly nonobvious, then to be consistent with the Court's reasoning in Hirao, additional limitations presented by subsequent dependent claims must also be nonobvious if the obviousness test is applied to the invention "as a whole."

Finally, a *prima facia* case of obviousness requires three criteria: 1) some suggestion or motivation in the reference to modify the reference or combine reference teachings, 2) a reasonable expectation of success, and 3) the reference must teach or suggest all of the claim limitations. (See MPEP Section 2142).

As to the first requirement, the reference's objective as a hydrogen generator represents a completely different problem to be solved compared to that of the present invention. There is no suggestion in the reference that suggest a plurality of rotating hydrogen flames could be used to ignite and completely combust an atomized liquid fuel stream. To the contrary, the reference suggests a means for *producing hydrogen* for the purposes of controlling emissions of internal-combination engines. Due to the widely different objective of the two methods, one cannot say that one teaches of suggests the other. The level of skill in the art cannot be relied upon to suggest a combination of references. (*See* Al-Site Corp. v. VSI Int'l Inc., 174 F.3d 1308, 50 USPQ2d 1161 (Fed. Cir. 1999).

As to the second requirement, the Houseman reference fails to suggest or disclose any of the problems associated with maintaining stable hydrogen flames from hydroxy gas under high-speed rotation as is disclosed in the present application. Therefore, one cannot say that one skilled in the art, at the time of the reference, would have a reasonable chance of succeeding in maintaining stable hydrogen flames under rotation simply by considering the Houseman reference and commonly available knowledge at that time.

Thirdly, if the proposed modification (i.e., the present invention) would render the reference unsatisfactory for its intended purpose (i.e. hydrogen generation), then there is no suggestion or motivation to make the proposed modification (In re Gordon, 733 F.2d 900, 221 USPTOQ 1125 (Fed. Cir. 1984); In re Ratti, 270 F.2d 810, 123 USPQ 349 (CCPA 1959). The reference invention clearly could not function as a liquid fuel combustion as it is disclosed. If the reference were modified to be a liquid fuel combustor, it could not operate as a hydrogen generator. Therefore, since the modifications would prevent the reference form operating as a hydrogen generator, the reference cannot support a claim of obviousness against the present invention.